An Injection Moulded Product and a Method for Its Manufacture

The present invention relates to an injection moulded product comprising an attached body which has been attached by an intermediate layer, and a method for the manufacture of an injection moulded product comprising a body which has been attached by an intermediate layer.

Background

Injection moulded products may need attached bodies, such as electronic components attached on a surface of the injection moulded product or embedded into the product. Attachment techniques according to prior art are complicated because the body must be attached to the product after the injection moulding, i.e. to the ready injection moulded product. Films or glue must be laid to the surface of the injection moulded product or the surface of the body after the injection moulding to attain a joint between the injection moulded product and the body. If the body is to be embedded in the injection moulded product, air often remains inside the product producing a cave near the body and weakening the strength of the injection moulded product.

Summary

By a method according to the invention, it is possible to avoid the above-mentioned problems. An injection moulded product according to the invention is characterized in that the body has been attached to the injection moulded product by an intermediate layer attached to the body prior to the injection moulding. The method according to the invention is characterized in that the body is attached to the injection moulded product by an intermediate layer adhered to the body prior to the injection moulding.

An intermediate layer, such as a thermoplastic adhesive bonding film or another thermoplastic film formed for example by extrusion, is attached to the body prior to the injection moulding. A body to be attached to an injection moulded product, either on the surface of an

injection moulded product or embedded into the injection moulded product, is easily attached in connection with the injection moulding.

Thermoplastic adhesive bonding films used as an intermediate layer have certain features which make them advantageous for connecting the injection moulding layer and the body. The injection moulding layer should be understood broadly in this context; it is any layer of any shape formed by the injection moulding. The injection moulding layer can cover the body partly or completely.

The thermoplastic adhesive bonding films can be attached to the body prior to the injection moulding, because they can be attached to the body by heating the film, and when the temperature of the film falls back to room temperature, it has no adherence but the bonds formed with other surfaces during heating remain.

The thermoplastic adhesive bonding films are a certain kind of an intermediate form between conventional thermoplastic films and adhesives. Their characteristics are in most cases a consequence of the orientation of the films. The preferred thermoplastic adhesive bonding films are based on modified polyolefins, modified polyurethanes or modified polyesters.

When an injection moulded product is formed, the body to be attached to the injection moulded product is first covered partly or completely with the intermediate layer, such as a thermoplastic adhesive bonding film. The body is then placed into an injection mould and the molten plastic is injected onto it. The hot plastic melts the intermediate layer, thereby forming a firm bond between the body and the injection moulding layer.

One important embodiment of the present invention is a smart card and a method for its manufacture. The smart cards are rigid cards comprising a so-called radio frequency identification (RFID) circuit which is contactless and is typically used at a distance of some tens of centimetres from a reader antenna. Such a smart card can be used for

example as an electrical purse, as a ticket in public service vehicles, or for personal identification.

Special advantages in addition to the mentioned general advantages are achieved in the processing of a smart card. The intermediate layer and the injection moulding layer protect the circuitry pattern and the chip, the uneven surface of the smart card blank can be flattened out by an injection moulding layer, and the manufacturing costs are low. The material basis of the smart card blank is not restricted by heat sealing properties which is the case when a rigid card is formed by laminating different layers together.

The production of a smart card comprises the following steps:

- a circuitry pattern is formed on the surface of a carrier web to be unwound from a roll,
- a chip is attached to the circuitry pattern by a suitable flip-chip technology,
- the intermediate layer in a web form is attached to the carrier web,
- the smart card blank web is sheeted to single smart card blanks or sheets comprising several smart card blanks,
- a rigid smart card is formed by injection moulding,
- the smart card is equipped with personal identification,
- sheets comprising several smart cards are punched into separate smart cards,
- the smart card is electrically encoded (not in all cases), and
- the cards are packed.

A body to be attached to an injection moulding layer in this embodiment is a smart card blank comprising a circuitry pattern and an integrated circuit on a chip on a substrate. The smart card blanks are usually produced as a continuous web. The smart card blank web according to the invention comprises an intermediate layer in a web form and a carrier web i.e. the continuous substrate, whose surface is provided with successive and/or parallel circuitry patterns which are each equipped with an integrated circuit on a chip.

Methods for attaching the integrated circuit on the chip to a conductive circuit include the flip-chip technology which comprises several techniques. The flip-chip technology can be selected from a large variety in such a way that the production rate of the process can be maximized at an appropriate level of quality and reliability. Suitable flip-chip methods include anisotropically conductive adhesive or film (ACA or ACF) joint, isotropically conductive adhesive (ICA) joint, non-conductive adhesive (NCA) joint, solder flip-chip (FC) joint, or possibly other metallic joints. In addition to the flip-chip technology, also a wire bond or a joint made by tape automated bonding (TAB) can be used. The chip can also be placed by the flip-chip technology onto a separate structural part which is attached to the circuitry pattern. Possible materials for the carrier web include *e.g.* polyester or biaxially oriented polypropylene. The material of the carrier web can also be another suitable material.

The intermediate layer attached onto the carrier web makes the attachment between the intermediate layer and the injection moulding layer possible. The intermediate layer can be attached to that side of the carrier web on which the circuitry pattern has been formed and to which the integrated circuit on a chip has been attached, but it is also possible that two intermediate layers are attached, one to each side of the carrier web. The intermediate layer protects the circuitry pattern on the carrier web and the integrated circuit on the chip from the effects of *e.g.* chemicals and ambient conditions during processing.

Possible materials for the intermediate layer in the smart card include thermoplastic adhesive bonding films which are attached to a substrate by means of heat and pressure, or other thermoplastic films formed for example by extrusion. Suitable thermoplastic adhesive bonding films are for example 3M™ Thermo-Bond Film 845, 3M™ Thermo-Bond Film 845 G (Thermo-Bond Film products from 3M, USA), EAF-200, EAF-220, EAF-240, UAF-420, UAF-430, UAF-440 (EAF and UAF products from Adhesive Films, Inc., USA), Sikadeflex® HS 11/90 VP 85 (Sika Werke GmbH, Germany) and Bostik thermoplastic film adhesives (Bostik, USA). A suitable material for the extrusion is for example Eastman 9921 copolyester (Eastman, USA).

Thermo-Bond Films 845 and 845 G are flexible and light-coloured thermoplastic adhesive bonding films. They are based on modified polyolefin. EAF-200 is a clear film based on ethylene copolymer, EAF-220 is a clear film based on ethylene vinyl acetate copolymer and EAF-240 is based on a similar compound as EAF-200 but has a higher melting point. UAF-420, UAF-430 and UAF-440 are films based on polyurethanes. They are clear or translucent.

Sikadeflex® HS 11/90 VP 85 is a transparent film based on polyurethanes. Bostik thermoplastic film adhesives are based on polyesters or polyurethanes.

The thermoplastic adhesive bonding films can be laminated to the carrier web by using various lamination techniques. The basic methods for lamination are pressing in a press or pressing in a nip formed between two counter surfaces. By applying pressing in a nip, it is possible to attain a continuous process. At least one of the counter surfaces forming the nip may be heatable, or the thermoplastic adhesive bonding film may be heated so that it becomes tacky before the nip. The process temperatures normally vary from 120°C to 170°C.

There must also be a certain dwell time in the nip which normally ranges from 2 to 15 seconds. The term dwell time refers to the period of time during which the smart card blank web stays in the nip. The pressure used in the nip varies from 60 to 700 kPa, depending on the thermoplastic adhesive bonding film. To obtain an optimum dwell time and pressure in the nip, the nip is preferably a nip longer than a nip formed by hard rolls. The nip can be for example a nip formed by a thermoroll and a resilient roll, wherein the pressure per unit area is lower than in a corresponding hard nip. One of the contact surfaces forming the nip can also be a shoe roll. The nip dwell time and pressure are selected according to the requirements of the thermoplastic adhesive bonding film in question. The material of the intermediate layer can also be another suitable material whose properties are at least equal to those of the above-mentioned materials.

The attachment of the integrated circuit on the chip to the carrier web can be performed on the same production line as the attachment of the intermediate layer and the carrier web to each other, or on a separate production line. After the attachment of the intermediate layer, the smart card blank web is sheeted so that it can be subjected to further processing in sheet form.

When the thermoplastic adhesive bonding film has been attached to the other or the both sides of the carrier web, the smart card blank is placed in an injection mould so that the thermoplastic adhesive bonding film comes into a contact with the injection moulding material, i.e. the molten plastic. When the molten plastic is injected onto the surface of the thermoplastic adhesive bonding film, the film is activated by the heat produced by the molten plastic, and the film and the plastic adhere to each other. When the thermoplastic adhesive bonding film and the injection moulding material cool, they form a firm bond. Suitable injection moulding materials include for example polyethylene (LDPE, HDPE), polypropylene (PP), acrylonitrile/butadiene/styrene (ABS) copolymer, polystyrene (PS), polyamide (PA), polyacetal (POM) and thermoplastic elastomer (TPE).

Brief Description of the Drawings

In the following, the invention will be described by means of drawings, in which

Fig. 1 shows a single smart card blank in a top view, and

Fig. 2 shows a side view of a smart card.

Detailed Description

Figure 1 shows a single smart card blank in a top view. The material of the carrier web 1 may be a material resistant to relatively high temperatures, such as polyester or biaxially oriented polypropylene. The carrier web 1 is a continuous web which contains circuitry patterns 5, each having an integrated circuit 4, at suitable spaces one after another and/or next to each other. The circuitry pattern can be made by printing the circuitry pattern on a film with an electroconductive printing

ink, by etching the circuitry pattern on a metal film, by punching the circuitry pattern off a metal film, or by winding the circuitry pattern of *e.g.* a copper wire. The circuitry pattern is provided with an identification circuit, such as a radio frequency identification (RFID) circuit. The identification circuit is a simple electric oscillating circuit (RCL circuit) tuned to operate at a defined frequency. The circuit consists of a coil, a capacitor and a circuit integrated on a chip, consisting of an escort memory and an RF part for communication with a reader device. The capacitor of the RCL circuit can also be integrated on the chip or the capacitor/s can be located outside the chip.

Figure 2 shows a smart card comprising a carrier web 1, an intermediate layer 2 which is attached onto the surface of the carrier web 1, and an injection moulding layer 3 which is formed on the surface of the intermediate layer.

The carrier web 1 is a plastic film. The material of the carrier web 1 can be for example polyester or biaxially oriented polypropylene.

A intermediate layer 2 is attached to the carrier web 1. During the processing, the intermediate layer 2 protects the circuitry pattern on the carrier web 1 and the integrated circuit on the chip 4 from ambient conditions and chemicals. The material for the intermediate layer 2 is a plastic film with suitable properties for further processing, such as a thermoplastic adhesive bonding film. On the intermediate layer 2 there is an injection moulding layer 3 which has been adhered to the intermediate layer 2.

The above description does not restrict the invention, but the invention may vary within the scope of the claims. The materials of the carrier web can be different from those presented above. The injection moulded product can be different, for example it can be a plastic transport container or another container comprising an attached body, for example a smart card blank for identification. The main idea in the present invention is that the injection moulded product comprising an

attached body can be made easily and cost-effectively by using an intermediate layer between the body and the injection moulding layer.